Discovering the coating structure of historic bowed string instruments: an analytical campaign by SR-FTIR microspectroscopy

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In many cases, the possibility to analyse a micro sample from an ancient bowed string instrument allows researchers to collect a wealth of information concerning materials used by the great Masters of violin-making and their construction procedures. In fact, the stratigraphic investigation may provide important information about (i) the treatments of the wood, normally involving proteinaceous materials and inorganic fillers, such as carbonates, silicates, sulphates, (ii) composition of the different superimposed layers of varnish, and (iii) organic or inorganic pigments dispersed in the binders of the different superimposed layers of varnish [1].

In the present work, a set of four micro-samples – collected from well-preserved violins made by Antonio Stradivari, Francesco Ruggeri and Lorenzo Storioni – have been mounted in cross-section and investigated throughout. The analytical approach has been developed on the embedded samples by means of synchrotron radiation (SR) FTIR micro-spectroscopy in reflection mode using a 15x objective, at the Chemical and Life Sciences branch of SISSI beamline (Elettra - Sincrotrone Trieste) [2]. Data have been collected in the MIR range in correspondence of each single layer of the stratigraphy, setting the lateral resolution in order to match the layer thickness (from few μm to tens of μm). A classification model has been constructed and validated to discriminate classes of materials according to the spectral information [3].

Preliminary results obtained from measurements performed by the micro-invasive SR-FTIR approach are elaborated and discussed, together with the analytical procedures, in order to characterise the features of the different samples.

References

[1] G. Fiocco, T. Rovetta, M. Gulmini, A. Piccirillo, M. Licchelli and M. Malagodi, *Appl. Spectrosc.*, **71** (2017) 2477-2487
[2] S. Lupi, A. Nucara, A. Perucchi, P. Calvani, M. Ortolani, L. Quaroni and M. Kiskinova, *J. Opt. Soc. Amer. B*, **24** (2007) 959-964
[3] M. Bevilacqua, R. Bucci, A.D. Magrì, A.L. Magrì, R. Nescatelli and F. Marini, Classification and class-modelling. In: *Data handling in science and technology. Chemometrics in food chemistry*. (F. Marini; Ed.) (Amsterdam, The Netherlands: Elsevier) **28** (2013) 171-233